Tech Tip

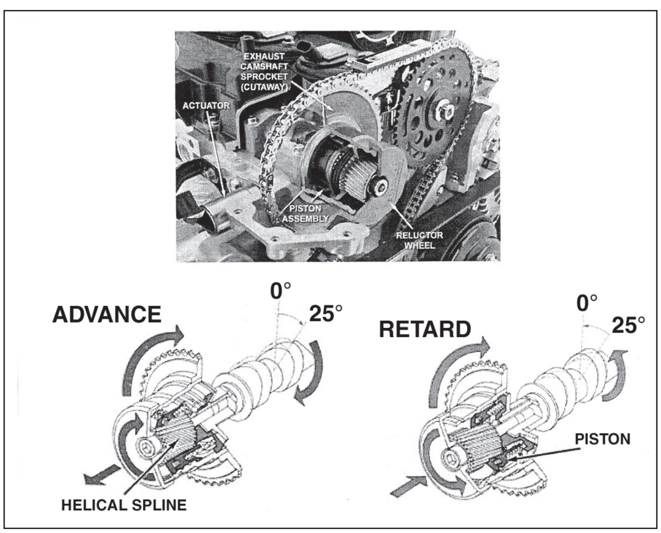


# SMART ENGINE SYSTEMS

## Servicing Vehicles Equipped with Variable Valve Timing

Engines equipped with Variable Valve Timing have special lubrication and maintenance requirements. Neglecting the vehicle manufacturer's service recommendations can result in major engine performance deficiencies. Imagine changing the oil and filter on a vehicle and having it return with some major driveability symptoms, in addition to an illuminated Check Engine Lamp and multiple codes stored in the PCM memory. Trust me… it can happen. Should this occur, it may require more than draining and installing the correct viscosity oil to return the vehicle to service. Read on to have a better appreciation of how the camshaft arrangement functions, and the importance of the proper viscosity oil and a scheduled maintenance for the vehicle.

Some vehicle manufacturers are equipping their engines with a variable valve timing system, which allows a continuous adjustment to the camshaft, referred to as cam phasing. This system allows adjustments to the valve overlap during all driving conditions to achieve optimum performance and fuel economy, while lowering the emission output. This arrangement has resulted in some vehicle manufacturers eliminating the EGR valve. GM advises that the camshaft position actuator allows the camshaft sprocket to change its position by as much as 50 degrees in relation to the camshaft on their system. GM applications utilize one of two systems that function in accordance with the following descriptions provided by GM:




*Courtesy of GM*

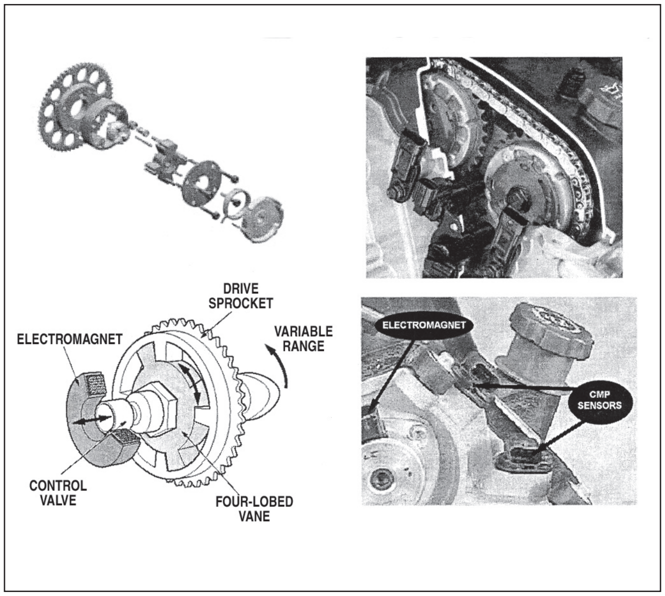
**FIG. 1**

***Spline Phaser System…*** On this system the components include the powertrain control module (PCM), pulse-width modulation (PWM) control valve, cam phaser, and camshaft position (CMP) sensor. The PCM controls the PWM valve, which directs engine oil in front of or behind the piston in the cam phaser actuator, in relation to engine speed and manifold absolute pressure (MAP) sensor inputs. Improper camshaft position can result in violent detonation or loss of power. (See Fig.1)

***Vane Phaser System…*** This design system utilizes a four vane-type camshaft position (CMP) actuator, which includes integral control valves and electromagnets. This system is controlled in the same manner as the spline phaser via a control valve; however, the internal components differ. Instead of using an internal piston with splines, a rotor with four vanes is connected to the end of the camshaft. The rotor is housed inside the stator, which is bolted to the cam gear (See Fig. 2). The rotor and stator are not mechanically attached, as with the splined phaser. Instead, they are connected via a hydraulic link, as oil pressure is controlled on both sides of the rotor vanes. By varying the balance of oil pressure on either side of the vanes, the camshaft position can be controlled. A return spring is positioned under the reluctor of the phaser to help return it to a 0 degree position.

The CMP actuator system is comprised of four actuator solenoids, four control valves, four vane style CMP actuators and four CMP sensors. The CMP actuators consist of a housing with an integral cam drive sprocket and cam sensor target wheel. Positioned inside the housing is a four-lobed vane with oil pressure chambers on both sides of each lobe. The four-lobed vane is bolted to the front of the camshaft and controlled by an integral oil control valve.

On systems that use the electromagnet, the PCM sends a 12 volt PMW signal to the electromagnet to activate the oil control valve. The oil control valve ports the pressurized engine oil to either the advancing or retarding chambers of the CMP actuator to change the camshaft position relative to the crankshaft position, as commanded by the PCM. The cam phasing is continuously variable within a range of 40 degrees for the intake valve timing and 50 degrees for the exhaust valve timing. When the engine is not running or when the CMP actuators are not commanded, the exhaust CMP actuators are parked at the full advance position and the intake CMP actuators are parked at the full retard position. The PCM calculates the optimum camshaft position based on engine speed, manifold absolute pressure, throttle position, crankshaft position, camshaft position, engine load and barometric pressure.




*Courtesy of GM*

**FIG. 2**

## FORD'S VARIABLE CAMSHAFT TIMING

Ford refers to their system as VCT (Variable Camshaft Timing). In a general overview, this system functions in much the same manner as the GM system, in that it enables a re-positioning of the camshaft(s) in relation to crankshaft rotation.

Ford identifies itself with four different types of VCT systems:

1) **EPS (Exhaust Phase Shifting):** With this system, the exhaust cam is the active cam being retarded.

2) **IPS (Intake Phase Shifting):** On this system, the intake cam is the active cam being advanced.

3) **DEPS (Dual Equal Phase Shifting):** With this arrangement, both the intake and exhaust cams are phase shifted and equally advanced or retarded.

4) **DIPS (Dual Independent Phase Shifting):** Both cams are shifted independently.

The previously mentioned systems incorporate four operational modes:

1) Idle
2) Part Throttle
3) Wide Open Throttle
4) Default Mode

During idle or low engine RPM with a closed throttle position, the PCM determines the phase angle based on air flow, oil temperature and engine coolant temperature. During part throttle and wide open throttle, the PCM determines the phase angle based on engine RPM, load and throttle position. The VCT system provides an increase in power, fuel efficiency and lower emission output. The IPS system provides improved engine torque. On some applications, Ford has eliminated the EGR system with the VCT system. Elimination of the EGR valve is accomplished by controlling the intake and exhaust valve overlap.

The VCT system functions by controlling the flow of engine oil in the VCT actuator. The PCM controls the duty cycle of the VCT solenoid, which affects the pressure and flow of the oil in the VCT actuator, thereby advancing or retarding the camshaft timing. One half of the actuator is coupled to the camshaft and the other half is connected to the timing chain/gear. Oil chambers between the two halves couple the camshaft to the timing chain. When the flow of oil is directed from one side of the chamber to the other, the pressure change forces the camshaft to rotate in an advance or retard position, depending on the direction of the oil flow.

## CORRECT OIL VISCOSITY AND GOOD MAINTENANCE

It is imperative that only the vehicle manufacturer's recommended oil viscosity be installed in a vehicle equipped with variable valve timing. The GM applications reflect 5W30 and Ford recommends 5W20. We have encountered a situation whereby 20W50 oil was installed by a lube tech who was unfamiliar with this system. Days later, the vehicle was towed to the dealer and the repairs were not covered under warranty. The diagnosis was a lengthy process, as the Check Engine Light was illuminated and multiple codes were stored in memory. Once the technician determined the performance condition occurred following a routine lube service, he went straight to the problem. Draining the crankcase and installing the correct viscosity oil returned the system to normal operation. The lube shop was responsible for the dealer's diagnostic charges, plus a new oil change.

**Very Important:** Clean, pressurized engine oil of the vehicle manufacturer's recommended viscosity is essential in order to provide proper system operation. Make certain the crankcase is properly filled and the oil level is within normal operating range. Never allow the oil to become contaminated due to neglect of maintenance, or through the addition of additives that can affect the viscosity of the lubricant. Engine oil pressure, oil viscosity, temperature and oil level can affect the operation of engines fitted with this camshaft arrangement.

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